Geophysical
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December 7, 1998

Ms. Magalie Roman Salas
Office of the Secretary
Federal Communications Commission
1919 M Street NW, Room 222
Washington, DC 20554

Dear Ms. Salas,

Response to FCC 98-208 Notice of Inquiry in the matter of Revision of Part 15 of the Commission's Rules Regarding Ultra Wide Band Systems

ET Docket NO. 98-153

Our submission of comments was completed this weekend, with the intention of filing electronically. Our E-mail submissions have been sent back, and the alternate method of sending a file indicates a server error. We realize today is the due date, and we respectfully request that you receive our submission a day late because of the server problems.

I just received a call back from Sheryl Segal who indicated that the server was indeed down all weekend. I am FedExing this, but will send it electronically today if the server comes back up.

Very best regards,

Alan E. Schutz

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Dear Ms. Salas,

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Geophysical Survey Systems, Inc. (GSSI) has been in the business of building and selling Ground Penetrating Radar systems (GPR) for 28 years. Our customers vary greatly in their uses and their geography. We have sold about 1200 radars in over 100 countries. Our customers include a great many US Government agencies, and we have for many years been listed in the GSA catalog. Two of our customers, the Department of Justice and the Energy Department, obtained licenses from the NTIA to operate our equipment.

The use of GPR by our customers in finding utilities in the streets has saved a great deal of money, and was potentially life-saving. It has also been able to locate leaks in gas and water lines. Civil Engineers, Geologists and Geophysicists are using systems every day to locate bedrock, sinkholes, map water tables, analyze soil stratigraphy, profile lake and river bottoms, and map snow and ice thickness.

No other non-destructive technique can provide such a rapid and accurate assessment of the conditions of concrete structures. GPR has been used to find voids under airport runways, in tunnel walls, in building and parking structures, and in historical monuments.

During the early '80s, we sold 100 systems to the nuclear power plant construction industry. The use of these systems to precisely locate rebar in the plant walls saved many hundreds of millions of dollars. It is interesting to note that these systems were operated by construction workers, not engineers or technicians.

The FBI and RCMP, as well as local law enforcement agencies have used our equipment to locate bodies. Other users have successfully located fine wires in walls.

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GSSI Radar Systems have been used at many well-known archeological sites, including the Great Pyramids in Cairo, the cliffs where the Dead Sea Scrolls were found in Israel, a site believed to be the location of Noah's Ark in Turkey, and the discovery of bones from the largest dinosaur, the Seismosaurus.

Over the past twenty years, GSSI systems have become a standard tool to evaluate hazardous underground sites in preparation for cleanup. From the relatively simple requirements of locating buried drums, underground storage tanks and waste disposal trenches, to the more complex tasks of mapping underground containment plumes and landfill boundaries, GPR systems can reduce the cost and risks of cleanup.

GPR is being used (and specified) to perform large-scale road and bridge surveys for asphalt thickness as well as deterioration. Some of these tests can be performed at highway speeds. The alternate to this technology is usually to take many cores, or in the case of bridges, stripping and replacing the asphalt cover. The GPR survey can continuously cover the area, while coring is only a very small sampling. GPR can determine which areas of a bridge may need to be replaced, thereby saving the cost of complete replacement. Our technology will provide municipalities and states with the information needed to best manage their limited infrastructure budgets. The money saved through the use of GPR is potentially enormous.

In summary, GPR has proven to be of great value in non-destructive testing in a wide variety of areas. In all the time we have sold and used GPR systems, we have had no problems interfering with other users. On the contrary, we sometimes are unable to operate in the presence of a powerful EM source.

Most of GSSI's sensors operate at power levels near 1 milliwatt, which, combined with the wide-band nature of the signal, is why we do not interfere with other equipment.

Answers to the questions put forth in Docket No. 98-153:

9A: What types of UWB devices can we expect to be developed?

The GPR business which GSSI is involved in is relatively limited. There are now probably 2000 systems worldwide, with several hundred being produced annually. With lower cost units, and regulation requiring the use of GPR before, during and after construction, the number could jump to as high as several thousand per year. The high volume uses will be in the consumer area, where potentially millions could be sold. In particular, I refer to such developments as the micropower radar developed by Lawrence Livermore Laboratory (LLL). An inexpensive stud finder and automobile crash-avoidance radar are two such areas. Another company is developing a short-range (within buildings) communications device, based on varying the Pseudo-random code placed on the signal. It is our belief that these three uses can operate at a significantly lower power than most GPRs, thus enabling large numbers to coexist with all the other narrow-band systems.

9B: What are the frequency ranges and bandwidths expected to be used by UWB devices?

GPR systems typically have pulse widths of 0.3 to 100 nanoseconds, corresponding to center frequencies of 10 MHz to 3 GHz. The high end will be two to three times the center frequency. The low end will be the Pulse Repetition Frequency (PRF).

9C: What are the expected total power levels and spectral power densities, peak and average, of UWB devices?

Most GPRs have an average power of no more than 10 milliwatts, with peak radiated power of 10 Watts. The spectral density is the order of 10^{-11} watts/Hz. We designed a higher power unit for a US Army laboratory for surveying the polar ice fields. This has been used in other deep probing operations, but only in remote areas. The average power of this unit is approximately 200 milliwatts, with peak power of 1KW.

9C: What are the expected or desired operating distances?

Our GPRs operate at depths of 1 meter to some tens of meters. In very special conditions, particularly a solid ice sheet, we can operate to hundreds of meters. Note that this operation is all through solids. The low-cost consumer items mentioned previously will either operate through inches of solids (stud finder) or through the air (anti-collision or in-house communications). Therefore these units can be designed to operate at substantially lower spectral densities than the "low-volume" GPRs. We do not feel that the spectrum will be substantially cluttered by these two classes of devices.

10A: Are there certain types of UWB devices or applications that should be regulated on a licensed basis under some other rule part? If so, on which rule parts?

For devices with average power less than 10 mw, and peak power less than 1 KW, we feel they should have no licensing required.

10B: If provisions are made for UWB technology under Part 15, how should we define UWB technology?

Signals with bandwidth at least 25% is a common and useable answer.

11A: Should the rules generally continue to prohibit operation of UWB systems within the restricted bands and the TV broadcast bands?

No. The restriction is not necessary to prevent interference by UWB signals. It is only necessary to limit the energy in each band. These UWB radiators generally are down in the spurious level. In stepped-CW systems, it is possible to select the frequencies so that they will not be in the restricted bands. However, the much less expensive impulse systems, which operate strictly in the time domain, can not have holes chopped in the spectrum. Further, the spectral density of the impulse system can be orders of magnitude less than the stepped-CW system, which only uses 256 to 1024 distinct frequencies. The impulse system can be designed so that its energy is completely smeared across the whole spectrum, putting it into the noise level at any one frequency.

11B: Are there certain restricted bands where operation could be permitted, but not others? If so, which bands and what is the justification?

Noise level operation should be permitted in all bands. See 11A.

11C: If certain restricted bands were retained, what impact would this have on the viability of UWB technology.

It would make time-domain systems impossible. Impulse systems such as GSSI's GPRs and the LLL technology all use impulse trains. Thus they are everywhere when viewed in the frequency domain. In fact, every transmitter ever made has energy in all bands. We just define most of its bandwidth as spurious. It is only an infinite signal which has no spurious signals. We are just asking to let our "Spurious" output be defined as spurious. The central fact is that by strictly limiting the signal in the time domain in these impulsive systems, all of the energy is spurious when viewed in the frequency domain.

12A: Are the existing general emission limits sufficient to protect other users of the spectrum, especially radio operations in the restricted bands, from harmful interference?

If the average power is limited to 10 mw, then that should be sufficient to avoid interference.

12B: Should different limits be applied to UWB systems?

As described above, applying frequency domain limits to a time domain system is problematical at best. Allowing the UWB systems to operate at a reasonable noise level is most appropriate. It is also important to realize the very limited ranges that these devices normally operate on.

12C: Should we specify a different standard for UWB devices based on spectral power density? Should these standards be designed to ensure that the emissions appear to be broadband noise?

Power spectral density is the appropriate method. This would also allow very low power impulse devices to have a fixed PRF, while higher power units would need to go to a pseudo-random pulse generator.

12D: What is the potential for harmful interference due to the cumulative impact of emissions if there is a large proliferation of UWB devices? Could the cumulative impact result in an unacceptable high increase in the background level? Should the Commission limit proliferation by restricting the types of products or should the rules permit manufacturers to design products for any application as long as the equipment meets the standards?

With reasonable requirements, it is unlikely that these short-range devices will increase the background in one location by anything substantial. The range of these devices is typically only tens of meters, with the power density dropping off sharply within that region.

12E: Should a limit on the total peak level apply to UWB devices?

We believe that an average power of 10 mw and a pulse peak of 1 kW are appropriate.

12F: Can emissions above or below a certain frequency range be further filtered to reduce the potential for interference to other users of the radio spectrum without affecting the performance of the UWB systems?

No. See 11A above.

12G: Are the existing limits on the amount of energy permitted to be conducted back onto the AC power lines appropriate for UWB devices?

Yes, there should be no difference.

12H: What operational restrictions, if any, should be required to protect existing users?

Limiting the spectral density should prove adequate. It may be desirable to have two different limits, one for test equipment (such as GPR) where the annual sales would be in the thousands, and consumer devices to be sold in the hundreds of thousands. In any event, if there is ever any interference caused by a UWB device, then it should be turned off.

12I: Is the use of UWB modulation techniques necessary for certain types of communication systems; if so, for what purpose?

Any UWB communication system must have a coding on the pulse train. That is necessary to isolate sets of transmitter/receivers from each other. If impulse radar is used in automobiles for collision avoidance, then they must be encoded to prevent interference with another user. The good news is that this modulation or encoding further smears the energy when viewed in the frequency domain, thus further reducing the possibility of interfering with a tuned receiver.

13A: Is a pulse desensitization correction factor appropriate for measuring emissions from a UWB device? Should any modifications be made to this measurement procedure for UWB devices?

This correction factor is not appropriate for impulse radars. It is designed for pulse modulated sinusoidal carriers. The proper measurement is to measure the peak power in the time domain, and the average power in the frequency domain using a 1 MHz bandwidth.

13B: Would another measurement procedure that does not apply a pulse desensitization correction factor be more appropriate for determining the interference potential of an UWB device?

Yes. See 13A above.

13C: The frequency range over which measurements are required to be made depends on the frequency of the fundamental emission. Is the frequency of the fundamental emission readily discernable for UWB devices? Are the current frequency measurement ranges specified in the rules appropriate for UWB devices or should these ranges be modified?

There is no specific fundamental emission. That is in fact the basis of the UWB systems. In the case of an impulse radar, a sampling scope can determine the pulse width, and then the formula in footnote 9 in the Notice of Inquiry can be applied.

13D: Are the measurement detector functions and bandwidths appropriate for UWB devices? Should these standards be modified and, if so, how?

A sampling scope should be used to measure the peak power. A spectrum analyzer with at least a 1 MHz bandwidth should be used to calculate the spectral density and average power. It should not use the quasi-peak measurement, but rather just an average.

14A: Should the prohibition against Class B, damped wave emissions apply to UWB systems or is the prohibition irrelevant, especially in light of the relatively low power levels employed by UWB devices?

The prohibition is obsolete. The spark gap transmitters it was designed against would not pass Part 15 using other tests.

14B: Comments are invited on any other matters or issues that may be pertinent to the operation of UWB systems.

GSSI is proud of the advances that we have made in many areas of non-destructive testing. We have seen and been a part of developing a technology that many initially believed couldn't work, to today's worldwide acceptance. There are now many manufacturers of this technology, and innumerable university study groups. There have been thousands of papers written and many international conferences about GPR technology. Our low emission levels didn't register on the regulators. We understand that it is time to bring this technology into wider acceptance, and that requires it be recognized and regulated by the FCC. It may be true that it is the potential of millions of consumer products that is forcing the issue. The manufacturers of GPR, such as GSSI, build expensive test equipment that is usually operated in relatively remote sites. At least it isn't used in the living room near the TV. We believe that reasonable requirements can be developed which will not hinder the growth of our wonderful industry, allow the consumer products to be brought to market, and protect the current users of the spectrum.

With best regards,

Dennis J. Johnson
President

Alan E. Schutz
Vice President, Engineering